EXTENDED REPORT

Smoking and musculoskeletal disorders: findings from a British national survey

K T Palmer, H Syddall, C Cooper, D Coggon

METHODS

In 1997–8, we mailed a questionnaire to 21,201 adults, aged 16–64 years, selected at random from the registers of 34 British general practices, and to 993 members of the armed services, randomly selected from pay records. Questionnaires were completed by 12,907 (58%) subjects, including 6513 who had smoked at some time, among whom 3184 were current smokers. Smoking habits were related to age, social class, report of headaches, tiredness or stress, and manual activities at work. After adjustment for potential confounders, current and ex-smokers had higher risks than lifetime non-smokers for pain at all of the sites considered. This was especially so for pain reported as preventing normal activities (with PRs up to 1.6 in current v never smokers). Similar associations were found in both sexes, and when analysis was restricted to non-manual workers.

Results: Questionnaires were completed by 12,907 (58%) subjects, including 6513 who had smoked at some time, among whom 3184 were current smokers. Smoking habits were related to age, social class, report of headaches, tiredness or stress, and manual activities at work. After adjustment for potential confounders, current and ex-smokers had higher risks than lifetime non-smokers for pain at all of the sites considered. This was especially so for pain reported as preventing normal activities (with PRs up to 1.6 in current v never smokers). Similar associations were found in both sexes, and when analysis was restricted to non-manual workers.

Conclusions: There is an association between smoking and report of regional pain, which is apparent even in ex-smokers. This could arise from a pharmacological effect of tobacco smoke (for example, on neurological processing of sensory information or nutrition of peripheral tissues); another possibility is that people with a low threshold for reporting pain and disability are more likely to take up and continue smoking.

A positive association has been found between smoking and back pain in many, but not all, of the epidemiological surveys that have examined the link. In some, a dose-response relationship has been described, and in a few prospective studies, smoking habits have been found to predict episodes of incident back pain.

Several explanations for the association have been proposed. Smoking might provoke disc herniation through coughing, or lead to pathological changes in the intervertebral disc through alterations in its nutrition, pH, or mineral content. Another possibility is that smoking has a pharmacological effect on pain perception. Alternatively, the association could be confounded by physical occupational activities that are more common in workers who smoke; or by neuropsychological or sociocultural factors (for example, threshold for reporting symptoms and illness behaviour) that differ systematically between those who become smokers and those who do not.

In a few studies, an association has also been described between smoking and pain at other body sites, including the neck, shoulder, and legs. An association with widespread pain would tend to favour a central or systemic rather than a local mechanism, and contrasting risks in current and ex-smokers might argue against confounding as an explanation. To investigate further, we explored the relation of smoking habits to musculoskeletal pain at various anatomical sites, using data from a postal survey of a community sample.

Abbreviations: PR, prevalence ratio; 95% CI, 95% confidence interval
hour, use of a computer keyboard or typewriter for more than four hours, and (in the past week) exposure to sources of hand transmitted or whole body vibration.

A smoker was defined as someone who had smoked at least once a day for a month or longer, and classed according to whether he or she still smoked regularly at the time of completion of the questionnaire (current smoker) or did not (former smoker).

The prevalence of each category of smoking status was determined by age, sex, social class, and reported frequency of headaches, tiredness, and stress; and, after direct standardisation for age and sex, according to physical occupational activities. Associations of regional pain with smoking status were examined by logistic regression with adjustment for potential confounders, and the findings were expressed as prevalence ratios (PRs) with associated 95% confidence intervals (95% CIs). These were derived from the corresponding odds ratios according to a formula proposed by Zocchetti et al.

**RESULTS**

Usable responses were obtained from 12 907 (58%) of those mailed. Altogether, 6513 subjects (3786 men and 2727 women) reported smoking at some time, among whom 3184 (1779 men and 1405 women) were current smokers.

Table 1 shows the relation of smoking habits with age, social class, and employment status, and report of frequent headaches or often feeling tired or stressed; and, after direct standardisation for age and sex, according to physical occupational activities. Associations of regional pain with smoking status were considered. The relation was evident even in ex-smokers, although stronger for current smoking and for pain associated with reported disability.

<table>
<thead>
<tr>
<th>Men (%)*</th>
<th>Women (%)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never smoked</td>
<td>Formerly smoked</td>
</tr>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>16–24</td>
<td>814 (63.3)</td>
</tr>
<tr>
<td>25–34</td>
<td>1516 (53.7)</td>
</tr>
<tr>
<td>35–44</td>
<td>1609 (48.6)</td>
</tr>
<tr>
<td>45–54</td>
<td>1652 (37.0)</td>
</tr>
<tr>
<td>55–64†</td>
<td>1317 (30.6)</td>
</tr>
<tr>
<td>Social class</td>
<td></td>
</tr>
<tr>
<td>I, II, IIINM</td>
<td>2279 (55.0)</td>
</tr>
<tr>
<td>III, IV, V</td>
<td>2499 (40.5)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>1423 (36.8)</td>
</tr>
<tr>
<td>Armed forces</td>
<td>560 (48.6)</td>
</tr>
<tr>
<td>Often feeling tired or stressed</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>4879 (48.3)</td>
</tr>
<tr>
<td>Yes</td>
<td>1961 (37.5)</td>
</tr>
<tr>
<td>Frequent headaches</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>6107 (46.0)</td>
</tr>
<tr>
<td>Yes</td>
<td>653 (38.1)</td>
</tr>
</tbody>
</table>

*Maximum number—a few subjects failed to answer all the questions.
†Includes 33 men and 39 women who were 64 years old when the questionnaire was mailed but 65 at the time of response.

Our data indicate a modest but consistent association between smoking and regional musculoskeletal pain which was not confined to the low back, but was apparent at all of the sites considered. The relation was evident even in ex-smokers, although stronger for current smoking and for pain associated with reported disability.

**DISCUSSION**

We found (data not presented). Similar associations were also found in those who responded to the questionnaire at the first invitation and those who required a reminder.

Current and ex-smokers were more likely to have a physically demanding occupation (a possible source of confounding), and more often reported feelings of frequent tiredness, stress, and headaches (which could indicate a lower threshold for reporting symptoms in general); but the pattern persisted in an analysis that adjusted for these factors and when analysis was restricted solely to white collar workers. This seems unlikely, however, as similar associations were found in early responders and those who only replied after a reminder. (For example, the PRs for hand and elbow pain preventing activity were exactly the same among current smokers in the two groups, and the PRs were respectively 1.5 versus 1.4 for neck pain and 1.6 versus 1.5 for shoulder pain.)

Current and ex-smokers were more likely to have a physically demanding occupation (a possible source of confounding), and more often reported feelings of frequent tiredness, stress, and headaches (which could indicate a lower threshold for reporting symptoms in general); but the pattern persisted in an analysis that adjusted for these factors and when analysis was restricted solely to white collar workers. Also, some people might have taken up or resumed smoking because of pain, although this would not readily explain the association found in ex-smokers. In addition, the association could in part reflect higher rates of smoking among subjects with inflammatory arthropathies (as has been reported for rheumatoid arthritis). However, the prevalence of such disorders in the general population is too low for this to have had a major impact.
Similar findings have been reported in a few other investigations. In a survey of Norwegian households, musculoskeletal pains (in the back, neck, upper limb, lower limb, and at several of these sites) were reported more often by current and ex-smokers than never smokers, after allowance for age, sex, comorbidities, mental distress, and physical demands of work; and somewhat higher risks were found in current than former smokers. Current smoking was also associated with incident pain (in the neck/shoulder region, low back, upper and lower limbs) in a five year follow up study from the metal industry, again after allowance for workload, mental distress, and occupation; and, in a Swedish population survey, current smokers had a higher prevalence of chronic widespread pain than non-smokers (OR for non-smokers vs smokers 1.60, 95% CI 1.04 to 2.46). In each case a dose-response relationship was found with daily cigarette consumption.

Such a pattern requires an explanation beyond effects local to the intervertebral disc. The possibilities seem to fall into two broad categories: a pharmacological effect of tobacco smoke or a neuropsychological or sociocultural difference that varies systematically between those who become smokers and those who do not.

Nicotine is a psychostimulant which affects both cortical and autonomic arousal. Thus, it could affect the manner in which the brain processes sensory stimuli and the central perception of pain, although studies of pain tolerance during experimental exposure to cigarettes and nicotine have reached inconsistent conclusions. Alternatively, tobacco smoking might cause general damage to musculoskeletal tissues through vasoconstriction, hypoxia, defective fibrinolysis, or other mechanisms that impair their nutrition or structure. We have found, in keeping with the survey of Brage et al., detectable effects in ex-smokers, and so a hypothesis that involves tissue damage or a prolonged resetting of the threshold for pain tolerance is better supported by the data than one which depends on transient pharmacological effects.

Another possibility is that subjects who choose to take up and continue smoking report pain at a lower threshold than lifetime non-smokers. For example, their willingness to articulate somatic symptoms or report them as disabling may differ systematically, reflecting differences of personality or illness behaviour (for example, neuroticism, extroversion, dependency behaviour, or tendency towards somatisation). If so, ex-smokers might be expected to offer responses closer to those of current smokers than lifetime non-smokers, and our data are consistent with this. Also in keeping with a confounding effect of this sort is a recent community survey in which adolescent smokers had multiple somatic symptoms, poorer self reported health, and greater use of healthcare services than did age matched non-smokers.

A few surveys have sought to assess pain tolerance according to smoking habits experimentally, using standardized painful stimuli, but the findings have been mixed. In the large Kaiser-Permanente Multiphasic Screening Programme, smokers were less tolerant than non-smokers of painful mechanical pressure on the Achilles tendon; and in a second smaller study they reported intolerance sooner than non-smokers in response to an occlusive limb tourniquet. But surveys of painful electrocutaneous stimulation have provided no evidence of a difference. Response to an experimental stimulus, however, is qualitatively different from that to inquiry about recent experience of pain.

One way to distinguish between the hypotheses of systemic effect and confounding by sociocultural factors might be to ascertain reported pain longitudinally in people who take up or give up smoking and compare it with those who maintain constant smoking habits. Investigations with this design have rarely been conducted, but in a survey from the metal industry, workers who gave up smoking during a 10 year follow up reported an increase in morbidity from widespread pain, whereas no change was reported by those who continued to

### Table 2: Risk of regional musculoskeletal pain according to smoking status

<table>
<thead>
<tr>
<th>Site</th>
<th>Never smoked</th>
<th>Former smoker</th>
<th>Current smoker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low back</td>
<td>% PR (95% CI)</td>
<td>% PR (95% CI)</td>
<td>% PR (95% CI)</td>
</tr>
<tr>
<td>Neck</td>
<td>n*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elbow(s)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand(s)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip(s)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knees</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low back</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neck</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder</td>
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<td></td>
<td></td>
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<tr>
<td>Elbow(s)</td>
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<tr>
<td>Hand(s)</td>
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<tr>
<td>Hip(s)</td>
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<td></td>
</tr>
<tr>
<td>Knees</td>
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</tbody>
</table>

*Number included in the analysis of neck pain. Numbers of participants who responded to the questions on smoking varied slightly according to the completeness of the responses on pain. All PRs were adjusted for age, sex, smoking status, and occupation.

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smoke. It seems possible that some subjects gave up their smoking because of poor health, but another explanation is that the threshold at which subjects report pain is modifiable by the central effects of tobacco smoke.

The associations that we have described are moderate in size, and may have arisen through confounding. Nevertheless, further investigation would be useful to clarify the findings, and to assess the implications for preventive advice and the direction of future research. If taking up smoking increases pain susceptibility, then this provides another reason to avoid the habit; but if the type of people who smoke report pain more readily, a search should next be made for the underlying mechanisms (and in particular the aspects of sociocultural difference that best explain the findings). This could be relevant both to helping people stop smoking and to understanding the mechanism of diffuse non-specific pain and the rising toll of musculoskeletal pain presenting to healthcare services.

ACKNOWLEDGEMENTS

This study was supported by a grant from the Health and Safety Executive. We are grateful to the Royal College of General Practitioners, the Primary Care Rheumatology Society, the 34 general practices that assisted in assembling the mailing lists, and the MRC staff who were involved in data handling. Denise Gould prepared the manuscript.

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doi: 10.1136/ARD.62.1.33

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